TECHNOLOGY NEEDS/OPPORTUNITIES STATEMENT

PROVIDE METHOD FOR MORE ACCURATE ESTIMATES OF WASTE CONSTITUENT RELEASE RATES AND MODES FROM WASTE

Identification No.: RL-SS42
Date: September 2001

Program: Environmental Restoration
OPS Office/Site: Richland Operations Office/Hanford Site
Operable Unit(s): Broad need potentially applicable to multiple operable units
PBS No.: RL-SS04 (RL-VZ01)
Waste Stream: Disposition Map Designations: ER-04 [technical risk score 3], ER-14 [technical risk score 5], ER-03 [technical risk score 3]
TSD Title: N/A
Waste Management Unit (if applicable): N/A
Facility: N/A

Priority Rating**:**

This entry addresses the "Accelerated Cleanup: Paths to Closure (ACPC)" priority:

_X_ 1. Critical to the success of the ACPC
____ 2. Provides substantial benefit to ACPC projects (e.g., moderate to high lifecycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays)
____ 3. Provides opportunities for significant, but lower cost savings or risk reduction, and may reduce uncertainty in ACPC project success.

Need Title**:** Provide Method for More Accurate Estimates of Waste Constituent Release Rates and Modes from Waste

Need/Opportunity Category: Technology Need.

Need Description**:** This need addresses specific technical gaps identified in the scope of the Groundwater/Vadose Zone Integration Project (Integration Project) at the Hanford Site and is written as an "integrated" need. The Integration Project is focused on providing the scientific and technical basis to ensure that Hanford Site decisions, including decisions related to long-term stewardship, are defensible and possess an integrated perspective for the protection of water resources, the Columbia River, river-dependent life, and users of the Columbia River resources. As such, this "integrated" need has both applied S&T components that are interrelated in addressing the specified technical gap. Individual efforts applied to resolve the technical gaps described in this need may address all or part of the components identified for this need. Where a specific technology need can be defined separately from an "integrated" need, a specific technology need statement has been written and is included elsewhere in the Hanford Site STCG Subsurface Contamination Needs (e.g., RL-SS25: Improved, Cost-Effective Methods for Subsurface Access to Support Characterization and Remediation).

To conduct site wide assessments of cumulative impact to the Columbia River and river supported life, the rates of release from waste source terms are needed. Limited data are available on actual release rates. Hence, the primary technical gap is the need for models to describe release rates from all waste that will reside at the Hanford Site in the post-closure period. Thus, models and supporting data are needed for radionuclide and chemical releases from solid waste burial grounds, past tank leaks, future tank losses, tank residuals, proposed immobilized low-activity waste (i.e., glass), past-practice liquid discharge sites (i.e., crib, ponds, ditches, reverse wells, french drains, and specific retention trenches), canyon buildings (i.e., PUREX, B Plant, T Plant, U Plant, and S Plant), PUREX tunnels, the PFP building, and the graphite cores of production reactors. These modeling results provide temporal and spatial information for system assessments.

Specific issues include the following:

– It is anticipated that some residual waste will reside in the tanks after retrieval, consistent with closure criteria established with the regulators. The solubility/leachability of key constituents in these residuals and the behavior of the released contaminants at the waste-sediment interface is important for setting closure requirements and for estimating future quantity and composition of releases from the tanks and the subsequent impact of the releases. Technetium has been identified as one of the first contaminants to evaluate. It is often a performance assessment driver due to its solubility and mobility in its pertechnetate form. However, recent investigations indicate that much of the Tc may be in the insoluble non-pertechnetate form. It is important to determine the behavior of this contaminant under leaching conditions of tank waste residual and at the waste-sediment interface as it enters the vadose zone. Indeed, the actual release rates of technetium, selenium, and uranium (i.e., the major predicted human health dose contributors) from the tank residuals are essentially unknown. A fundamental understanding and capability to simulate releases from salt cake, sludge, and hard heal in Hanford tanks is needed (Technology Need RL-WT068). This effort supports future studies of tank waste patterned after the Retrieval Performance Evaluation (DOE 1999[RPE]).

– Appropriate release rates from a soil-waste matrix near unplanned tank releases are also needed. The soils have been modified due to contact with high heat and high pH tank wastes, effectively producing a new "waste form." The rate of release from these areas to underlying soils needs to be determined through activities within Technology Need RL-SS28. The results from those studies will serve as a basis for developing the release model in this need statement. In addition to the release and mobility of past tank leaks that have formed a new waste form in the subsurface, it is important to develop the knowledge required to estimate the release and migration of waste that will follow past tank leaks.

> Future tank losses and tank residuals from the same tanks will have the opportunity to travel the same path within the vadose zone as the past tank leak. Thus, the influence of the initial leak on the original soil/sediment profile is important to understand as the basis of future releases and their migration and fate.

In addition to residual tank wastes and the vadose zone environment containing past tank leaks, there is a need to develop, document, and obtain technical peer acceptance of a release models for virtually all wastes forms that will remain at the Hanford Site after closure. Release models for graphite cores were developed and applied in the Surplus Production Reactor Environmental Impact Statement (EIS) (DOE 1989, DOE 1992). The RPP is developing release models for low-activity waste glass. Soil-debris models based on solubility and adsorption/desorption physics have been developed and employed for solid waste burial grounds, but may require peer review to document their acceptance. Diffusion-based release models and data are being developed for application to high-integrity concrete containers, but will require peer review before application in analyses supporting large-scale disposals in Hanford Site burial grounds. Conceptual models and supporting data are needed for several key wastes at the Hanford Site including (a) the canyon buildings and their contents, (b) the PUREX tunnels, (c) the PFP facility, (d) ancillary piping throughout the chemical separations areas, (e) stack scrubbers for iodine-129, and (f) the past-practice liquid discharge sites. Some future wastes are still poorly defined but will also require inclusion in a system assessment. These include secondary waste streams and waste disposals generated by the future chemical separation of tank waste into high- and low-level fractions, and the vitrification of wastes. Examples are radionuclides such as technetium-99 separated from both the high- and low-level fractions and returned to DOE for disposal, and failed melters from the vitrification plants.

Schedule Requirements:

Earliest Date Required: 8/1/99

Latest Date Required: 9/30/05

The Integration Project S&T roadmap (DOE/RL-98-48, 2000) indicates the information that is required over the next 6 years to meet the objectives of the Integration Project. Information associated with contaminant release into the vadose zone is needed in the FY03 timeframe to support the System Assessment Capability.

Because of the variety of contaminant release models that need be developed, documented and peer accepted prior to issuance of a regulatory decision-assisting System Assessment, it may be necessary to schedule this activity over a longer time frame. Thus, scheduling peer review and acceptance of release models very near the time they will be needed to support the assessment (i.e., an environmental impact statement, a composite analysis), rather than requiring peer review and acceptance before the proposed models can be used in prototype simulations.

***Problem Description*:** This need falls under the Inventory Technical Element within the S&T Endeavor. Inventory is defined as the total quantity of radiological and chemical constituents used and created at the Hanford Site, and their distribution in and release from facilities, waste disposal sites, the vadose zone, groundwater, and Columbia River ecosystem. The Inventory Technical Element is intended to address the need for estimates of radionuclide and chemical contaminants that have been or are expected to be released to the Hanford Site soil column. Such an inventory would represent the total amount of selected radionuclide and chemical constituents at the Hanford Site and their distribution among and release from facilities, waste disposal sites, vadose zone, groundwater, and Columbia River. The objective of the Inventory Technical Element is to enhance protection of human health and environment by providing estimates of the location, amounts, concentrations, chemical form, and mobilization/release mechanisms of key inventory components, which provides the necessary input to site-wide subsurface system assessments. An implicit goal of this research is to provide scientifically defensible knowledge and data and identify existing and new S&T that will serve as input to DOE's decision-making process for Hanford cleanup.

The goals of the inventory technical element are largely twofold. First, a consistent approach and set of assumptions for providing information on waste site inventories across the Hanford Site needs to be established to ensure that a site-wide inventory data set is available for system-wide and project-specific impact assessments. Second, key chemical and radiological contaminants and soil sites need to be identified, and estimates of the amount and release characteristics of these key contaminants in different waste forms and storage/disposal areas (e.g., tanks, solid waste burial grounds, other) need to be validated.

A good understanding of inventory and release is key to a system assessment, because the potential groundwater and river contamination is proportional to the amount of radionuclides and chemicals that are disposed on Hanford Site and capable of migrating off the Site. Technical information needed to determine inventory include 1) locations, amounts, and concentrations; 2) characteristics of the radionuclide or chemical compound; 3) mobilization and release mechanisms and rates; and 4) the change in inventory because of natural processes (e.g., decay), remediation activities, and Hanford Site operations. In addition to inventory estimates, mechanisms must be identified that result in release of the inventory from facilities into the vadose zone, unconfined aquifer, or the Columbia River. Because the long-term configuration of the waste inventory depends on future remediation and land-use decisions, a baseline estimate of end-state inventory distributions must be defined.

Benefit to the Project Baseline of Filling Need: Completion of release models for all wastes based on available data and peer accepted methods is essential to any site-wide or system assessment. Currently, there is no single and consistent suite of containment failure and contaminant release models for the disposals and remediations planned at the Hanford Site. This must include wastes in a post-closure setting in the 100 B/C, 100 K, 100 N, 100 D, 100 H, 100 F, 300, 200 West and 200 East Areas. Because some of the site-wide analyses are required by DOE Order, they will be completed even if the development of data supported and peer accepted release models is not. System assessments conducted without the supporting scientific work are completed and submitted at risk of being rejected. Rejection could impact DOE/HQ issuance of approval for continued disposals, (e.g., LLW disposal in solid waste burial grounds in 200 West, LLW disposal in solid waste burial grounds in 200 East, and *Comprehensive, Environmental Response, Compensation, and Liability Act* (CERCLA) cleanup waste disposal in the Environmental Restoration Disposal Facility).

***Functional Performance Requirements*:** The techniques applied or information that is obtained must estimate containment failure and contaminant release such that the information can be applied toward the conceptual models, fate and transport numerical models, site-specific, and system assessment capabilities that are being developed as part of the Integration Project.

Work Breakdown Structure (WBS) No. : 1.4.03.4.4 ***TIP No.:***

Relevant PBS Milestone: PBS-MC-042

***Justification For Need*:**

Technical: Current waste constituent release models are not sufficient to estimate the mechanisms and rates of release for all Hanford waste types (e.g., solid wastes, residual tank waste, canyon and PFP buildings, PUREX tunnels, past-practice liquid discharge sites). These estimates are needed for quantifying potential source terms for contaminants.

Regulatory: Information obtained by addressing this need will provide an improved technical basis for making site regulatory decisions and therefore reduce the uncertainty associated with the basis for these decisions. Supplemental guidance to DOE Order 5820.2a, and draft DOE Order 435.1, require a Composite Analysis of all post-closure LLW to estimate long-term all-pathways human health impacts. Thus, inventory and release models for all post-closure wastes are needed. A Composite Analysis was completed in 1998 (Kincaid et al. 1998) and must be updated on a 5-year cycle. The Composite Analysis is a companion analysis to performance assessments for active and planned LLW disposals, and remedial actions. Thus, continued disposal authorization at the Hanford Site requires that this the composite analysis be supported and periodically completed. Similarly, continued DOE/HQ support for records of decision for remedial actions requires periodic completion of a composite analysis. The Composite Analysis offers a real opportunity to first quantify and then investigate the issue of uncertainty, and the related issue of the value of additional data investments.

Environmental Safety & Health: This need addresses broad site-wide technical issues and, as such, crosscuts multiple applications that each may have specific environmental safety and health issues.

Potential Life-Cycle Cost Savings of Need (in $000s) and Cost Savings Explanation: The estimated life-cycle cost savings associated with filling this need is $200M. This estimate is based on an assumed savings of 5% of the total Hanford remediation life-cycle cost of >$5B. Estimated savings are due to information and data gained by filling this need that supports decisions for cost effective remediation and long-term stewardship.

A scientifically supported and peer accepted compilation of containment failure and contaminant release models would be of great value to the Hanford Site and would establish a key element of several future analyses including EISs, PAs, feasibility studies, and composite analyses.

Cultural/Stakeholder Concerns: This technology need supports the resolution of cultural and stakeholder concerns as expressed by the CRCIA Team in "Columbia River Comprehensive Impact Assessment, Part II: Requirements for a Columbia River Comprehensive Impact Assessment." [Stakeholder and Tribal Nation concerns about the completeness and consistency of the assembly of containment failure and contaminant release data and estimates are expressed in the CRCIA Part 2 document (DOE 1998)] The regulatory, stakeholder and Tribal Nations also expressed a strong interest in formulations of the system assessment that would quantify the uncertainty in future impacts

Other: None.

Current Baseline Technology: N/A

End-User: Richland Environmental Restoration Project

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References:

United States Department of Energy. 1998. *Columbia River Comprehensive Impact Assessment, Part II; Requirements for a Columbia River Comprehensive Impact Assessment*. DOE/RL-96-16. United States Department of Energy, Richland, Washington.

United States Department of Energy. 1999. *Retrieval Performance Evaluation Methodology for the AX Tank Farm*. DOE/RL-98-72. United States Department of Energy, Richland, Washington.

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Risk Element Index to Linked Needs.

RL-SS43	Improvements to Ecological Risk Assessments and Analysis of Population-level Impacts
RL-SS44	Improvements to Human Health Risk Assessments
RL-SS45	Establishing Technical Basis for Socio-Economic Risk Assessments
RL-SS46	Modeling Risk Knowledge